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The absolute electron-impact optical emission cross sections of numerous vibrational bands of the second positive band system of the nitrogen molecule have been measured for electron impact energy from threshold up to 600 eV. From the optical data the apparent electron-impact excitation cross sections for five vibrational levels of the $C^3\Pi_u$ electronic state of the nitrogen molecule have been determined.

We have constructed a new apparatus for measuring the electron-impact optical cross sections for infrared emissions using a Fourier Transform spectrometer for optical detection. This apparatus allows us to study many important infrared emissions which could not be detected previously by our photomultiplier optical detection systems.

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Final Technical Report (1 August 93 - 31 July 96)

(AASERT-93) Collisions of Atmospheric Gas Molecules

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We have conducted a comprehensive study of the electron excitation of the second positive band system of the N_2 molecule as well as the excitation of the $C^3\Pi_u$ electronic state of the N_2 molecule. We have measured the absolute optical emission cross sections of numerous (v', v") vibrational bands of the second positive system for electron impact energy from threshold up to 600 eV. The relative optical emission cross sections are compared with theoretical calculations. From the optical data we determine the apparent electron-impact excitation cross sections for five vibrational levels of the $C^3\Pi_u$ electronic state of N_2. Using the Franck-Condon principle we determine that in an electron beam excitation experiment the population of the first three vibrational levels (v=0,1,2) of the $C^3\Pi_u$ electronic state is primarily due to direct excitation whereas cascade plays a significant role for populating the next two vibrational levels (v'=3,4). The relative intensities of the various vibrational bands of the second positive system observed in a dc discharge have been measured and compared with the results of the electron-beam excitation experiment.

The use of Fourier Transform spectroscopy for detecting infrared radiation emitted in an electron-beam excitation experiment has been explored. For this purpose we have constructed a special electron-beam excitation apparatus in which the radiation from the excited atoms is directed to a BOMEM Fourier-Transform Infrared Spectrometer. An InGaAs detector covers the wavelength region from 850 nm to 1.7 μm, and an InSb detector (with liquid nitrogen cooling) is used from 1.4 μm to 6.7 μm. This apparatus allows us to monitor, in electron excitation experiments, many important infrared emissions which we could not detect previously by our photomultiplier optical detection system.